How does corruption hurt growth? Evidences about the effects of corruption on factors productivity and per capita income*

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Abstract

Corruption is a phenomenon that plagues many countries and, mostly, walks hand in hand with inefficient institutional structures, which reduce the effectiveness of public and private investment. In countries with widespread corruption, for each monetary unit invested, a sizable share is wasted, implying less investment. Corruption can also be a burden on a nation's wealth and economic growth, by driving away new investment and creating uncertainties regarding private and social rights. Thus, corruption can affect not only factors productivity, but also their accumulation, with detrimental consequences on a society's social development.

This article aims to analyze and measure the influence of corruption on a country's wealth. It is implicitly admitted that the degree of institutional development has an adverse effect on the productivity of production factors, which implies in reduced per capita income. It is assumed that the level of wealth and economic growth depends on domestic savings, foster technological progress and a proper educational system. Corruption, within this framework, is not unlike an additional cost, which stifles the "effectiveness" of the investment. This article first discusses the key theories evaluating corruption's economic consequences. Later, it analyzes the relation between institutional development, factor productivity and per capita income, based on the neoclassical approach to economic growth. Finally, it brings some empirical evidence regarding the effects of corruption on factor productivity, in a sample of 81 countries studied in 1998. The chief conclusion is that corruption negatively affects the wealth of a nation by reducing capital productivity, or its effectiveness.

Key words: Corruption, economic growth, factor productivity, Institutional Economics, capital accumulation.

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1 Introduction

Corruption is a phenomenon that plagues many countries and, mostly, walks hand in hand with inefficient institutional structures, which choke the effectiveness of public and private investment. In countries with widespread corruption, for each monetary unit invested, a sizable share is wasted, implying that less investment are made, in fact. Corruption can also be a burden on a nation's wealth and economic growth, by driving away new investment and creating uncertainties regarding private and social rights. Political and institutional risks are always considered by domestic and international investors. When such risks are high, investment projects are postponed or even cancelled. In extreme cases, chronic corruption leads countries to a state of permanent political crises, resulting in overthrown governments and civil wars.[1]

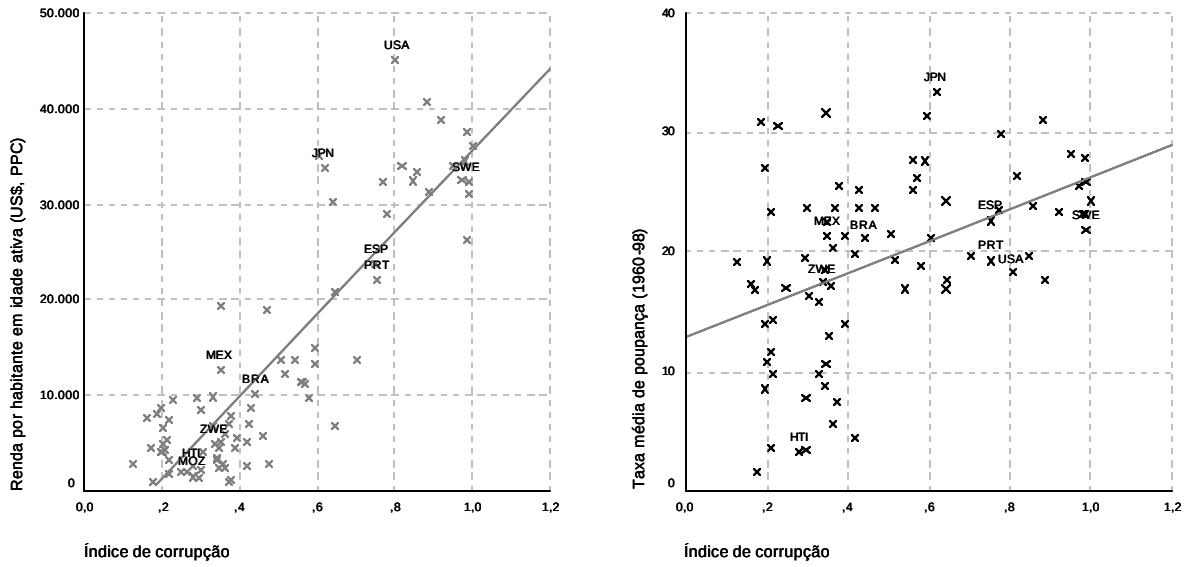
Thus, corruption can affect not only the productivity of the productive factors but also their accumulation. These two aspects provide a good idea how damaging endemic and chronic corruption can be to a society's wealth, economic growth, and social and human development. The graph below is a quite naive illustration of the impact brought by corruption on a nation's wealth. Using a sample of 81 countries, it shows (a) PPP-adjusted per capita income, in US$, compared to the index of perceived corruption in 1998; and (b) this same index compared to average savings rates between 1960 and 1998. The smaller the perceived corruption in a society, the higher its position in this index, measured from 0 to 1, and also the greater its per capita income. There is also a positive relation between investment rate in fixed capital (average during the 90s) and the absence of corruption, showing how investors react to potential risks in such society.

The aim of this article is to analyze and measure the influence of corruption on the per capita GDP of an economy. It is implicitly admitted that the degree of institutional development impacts negatively on the productivity of the productive factors, implying in

[1] This last aspect, linking corruption, political instability and growth, is not discussed in this article. Another aspect not analyzed here but worthy of mention is the relation between corruption and development, the latter term meaning the guarantee of minimum life standards for all inhabitants of a country. It should be remembered that in several economies corruption implies in reduced effectiveness of social investment, caused by deliberate inefficiency of these policies or outright theft of public funds aimed at fighting poverty, improving health or education, and so on.

shrinking per capita income of a country[2]. Intuitively, the argument presented here is as follows. The starting point is the belief that the level of wealth and economic growth, i.e., wealth accumulation along time, depend on domestic savings to finance new investments and technical progress, which in turn allow greater labor effectiveness, and on investments in education, that also expands labor productivity. Within this framework corruption is not unlike a cost that reduces the investment "effectiveness". Everything happens as if the creation of new wealth for the future necessarily incurs in waste of scarce economic resources. Thus, corruption renders investments and the cost of capital more expensive, demanding that the population give up more of its present consumption to achieve economic growth.

Graph **Perceived corruption, per capita income and average savings rate, selected countries, 1998**



Source: World Bank (2000) and Kaufmann, Kraay and Zoido-Lobatón (1999).

[2] There is ample literature on aspects related to institutions, institutional changes and corruption. Examples are, Ades, A. & Di Tella (1996), Boycko, Shleifer & Vishny(1995), Cartier-Bresson(1997), Hampton (1996), Harriss-Withe & White, eds(1996), Jones(1996), Khan(1996), Klitgaard(1991), Kong(1996), Kurer(1993), Porta & Meny eds.(1997), Porta(1997), Shleifer & Vishny(1994), Sidel(1996), Theobald(1990) and White(1996).

This article is part of a new trend in social science research, one that studies corruption using analytical tools provided by economics. There are clear advantages in studying this phenomenon with this methodology. Corruption involves the search for pecuniary gains, and it benefits from skewed information and problems in rationality and cooperation. Political Economy supply a set of tools to analyze institutional evolution and supplement (or criticize) sociological and anthropological approaches on the issue. To study concepts such as wealth searching and clientage under the light of economics can be easily achieved by redefining the agents' objective function. They can be considered rent-seekers. However, economic analysis of corruption must be complemented with positive Political Economy, since the study of social rules and institutions is essential to define the payoffs that drive the agents' decision process, in special regarding productive allocation and capital accumulation.

The second part of this article discusses the main theoretical approaches that evaluate economic consequences of corruption within modern Political Economy. Later, in the third part, the relation among institutional changes, factor productivity and per capita income is analyzed, based on the neoclassical approach to economic growth. Based on this theoretical model, the fourth part estimates the economic effects of corruption, using a sample of 81 countries surveyed in 1998. Final remarks on the effects of corruption close the article.

2 Economic consequences of corruption: three theoretical approaches

Within modern Political Economy three main views try to shed some light on the economic consequences of corruption. They are complementary among themselves and form, as discussed below, a theoretical framework for the analysis of the relation among rules, institutions, motivations of economic agents, corrupt behavior and all their economic and social consequences[3]. The first is associated to the theory of rent-seekers; the second, to the economic theory of bribe; and the third, to the relation between economic performance (efficiency and growth) and corruption.

[3] For more on this topic's basic bibliography and approaches involving positive Political Economy, see Silva (1994, 1996a, 1996b, 1996c, 1996d, 1996e).

The theory of rent-seekers was developed by Krueger (1974), Tullock (1967, 1990) and Bhagwati (1982, 1983)[4]. According to this view, economic agents have a basic motivation: rent-seeking. They try to obtain the highest rent, or income, possible within or without the rules of economic and social conduct. However, the search for income can imply in transfers within society, through monopolies or other forms of privileges. The activity associated to this search for income is called rent-seeking.

Consider the case of agents who seek rent within the rules of the game, without violating the law. Imagine the following situation: in a given country, there is a constitutional monopoly that endows a company with the exclusive right to extract and refine petroleum. Traditional theory of imperfect market structures argues that the monopolist has its excess increased at the expense of a reduction of the consumers' welfare. Society as a whole (and that includes managers, workers and shareholders of the monopolist company) forfeits part of its welfare, since in a monopoly a given part of the installed capacity will not be used. In theory, except for this dead-weight loss, any transfers between the producer and consumers should result in zero net losses.

Yet, according to the rent-seekers theory, there is a net loss for this society. The monopolist company, in order to assure its right to monopoly, must channel productive resources into advertising and lobbying activities. Or it can also invest human and physical capital in unproductive work related to political pressure and company image, with the sole purpose of maintaining the monopoly.

Another example of rent-seeking activity is found in protectionism. In this case, traditional economic theory considers social costs, in terms of lost welfare, owed to the dead weight created by a tariff and finds existing transfers from consumers to domestic producers. Other than the dead-weight, there should be no net losses for society. But, not unlike the case of monopolies, companies enjoying closed markets employ human and financial resources in unproductive activities, mainly lobbying.

Rent-seeking activity comprises a competitive market. Several agents try, as much as possible, to obtain privileges or obtain rent from other groups. However, only some agents or groups of agents will achieve their goal: the end result implies necessarily in a

[4] See Tollison (1982) for a comprehensive review of the literature on rent-seeking behavior.

waste of economic resources. This cost associated to rent-seeking activity has an important qualitative dimension. Much highly talented human capital is allocated to these unproductive, yet very profitable, activities. Consequently, rent transfers within a society tend to penalize talent allocated to productive activities. The result is that this income transfer is matched by considerable waste of assets and talent: there is a steep cost of opportunity associated to the rent-seeking activity.

Another additional cost associated to rent-seeking activity is related to rent transfers. In a competitive society, individuals are remunerated based on their productivity (except when market imperfections exist). In this society, rent can only be transferred through public policies based on technical criteria. However, in a society where rent-seeking activities prevail, labor remuneration can be reallocated according to the relative power of certain groups within society. From the standpoint of economic equity, income redistribution sponsored by rent-seeking activity may reward the power of influence, rather than merit and capacity.

Consequently, in a society split among competitive factions, which seek to transfer rent, the outcome of the social game can have negative results: the costs of rent-seeking activity are greater than the benefits obtained by some agents or groups. The reason why agents prefer rent-seeking activities in lieu of productive activities resides in the fact that it can be more profitable for a skilled and educated technician to work as a lobbyist than as a scientist or technologist. The rules of the economic, political and social game (institutions, laws, governmental regulations and moral values, i.e., self-imposed rules) generate the payoff system that steers decisions regarding economic resources – both financial and human. These rules can even force agents to perform rent-seeking activities. One example of this is overregulation: in many developing countries, the bureaucracy involved in opening a business presents such formidable hurdle that agents are forced to invest resources, in the form of time and talent, in unproductive activities.

The relation between the theory of rent-seeking and corruption can be found in the very definition of the objective function of public and private agents and in the incentive structure prevailing within the society. Theoretically speaking, if allowed, all agents will seek rent within and without the law, if they choose to disregard moral or legal restrictions

that penalize the initiative in some respect. Corrupt and corruptive agents can be modeled as rent-seeking agents. The difference between them and de facto rent-seekers is that the corrupt disregard the law.

Evidently, just like in a lottery, much talent and resource will be allocated in unproductive activities by the rent-seekers. Some will win, many will lose and society as a whole will be wasting economic resources. Thus, from the economic standpoint, corrupt competition among interest groups (organized groups of corrupt rent-seekers) creates cost and inefficiency[5].

In developing countries this Political Economy view of corruption tied to the rent-seeking theory is especially common. Social and development programs are overseen by public agents facing overwhelming demand for scarce resources. There are generous incentives to receive bribes and to participate, as a rent-seeking agent, in groups of managers-clients. Such a state of affairs brings ominous consequences mainly in poor countries.

This view of corruption, the result of the outlaw rent-seeker, can be complemented by Political Economy of Bribe (Rose-Ackerman, 1978). The economic study of bureaucratic and legal institutions cannot forgo graft and bribery, mainly because of their ties with the inherent conflict between public goods and the market.

In an economy of perfect competition, exchange relations between private agents are impersonal and seek to maximize each one's utility function. A service provider will sell its work to any other agent as long as the sale is satisfactory from the private standpoint. Likewise, the buyer of a service will demand it from any agent, provided that the exchange will bring the most welfare. In a perfect State, comprised of professional bureaucrats, whose behavior is strictly public, decisions will also not involve any personal criteria. Public agents simply maximize the social welfare function and provide society with public goods, in the most efficient way possible.

The world of corruption and graft drifts away from the pure model exactly in an aspect relevant to this analysis: the establishment, one way or another, of personal relations between public and private agents. Bribery can be defined, in spite of generalities, as a financial means to transform impersonal relations into personal ones. This is usually done

[5] On this regard, see Mbaku(1992).

with the intent to illegally transfer rent within a society, misappropriate third-party assets, or simply try to obtain preferred treatment, as happens in most corruption cases in the lower administrative levels.

Political corruption, from this perspective, can be described as follows. Public agents in general and politicians in special take rational decisions. Their key objective is to be elected, reelected and obtain a flow of income, i.e., the buildup of personal wealth through the buildup of power. The political market is not perfect and voters do not have full control over the work of their elected officers. Moreover, much asymmetric information and the process of political negotiation (log-rolling) creates opportunities for the payment of lobby services.

When there is some type of control on the behavior of politicians, there is an implicit exchange between the procurement of bribes and the possibility of reelection. If, for instance, the voters of a representative believe that he is more keen on defending the interests of some pressure group than in championing those of his voters, chances that he will not be reelected will grow considerably. However, the graft inherent to the lobby representation can make up for his loss in the upcoming elections. This control over graft depends largely on the moral rectitude of each individual politician and of the public interest regarding political behavior. While social control cannot fully do away with such ways, it can restrict them.

In final analysis, under this aspect, corruption is associated to market imperfections. As a rule, governments are large buyers of capital goods and infrastructure works, whose prices at times are set not following market logic. Public works involve vast sums of money, which are handled by a small number of public and private agents. They can create technical arguments, factual or not, justifying their overcharging, which will provision the bribe fund to be shared by all parts involved in the misdeed. It is difficult to oversee the behavior of public agents that take these financial and economic decisions, since information is imperfect and at times skewed. This opens the way for corruption.

The third and most recent intervention of economics in the realm of corruption is credited to Shleifer & Vishny (1993), among others. The key concern is the relation between institutions, corruption and economic growth. These authors sustain that corruption

sprouts with more vigor when (i) institutions create excessive regulation and centralization of government, and (ii) political institutions are not overseen by a large share of society.

The greatest impact of corruption is its costs in terms of lower growth. Bribes, unlike taxes, involve distortion in the use of the government structure and, being crime, must be kept secret. This results in additional costs to obtain bribes necessary for the co-optation and maintenance of networks of corrupt workers of public organizations, for the manipulation of budget information, and so on. The result of this corruption is diminished economic growth, due to resources allocation to unproductive activities, and the distortion of social policies aimed at economic development.

There is yet another mechanism by which corruption reduces investment. Foreign investments in a given country can be jeopardized when public agencies of this country, controlled by politicians and bureaucrats, demand bribes from private agents in charge of implementing such projects. Considering that such "informal costs" diminish the profitability of these ventures, foreign investors may prefer to place their money in countries less plagued with corruption.

The three aspects analyzed in this section lead us to conclude that corruption corrodes a country's wealth and economic growth through economic inefficiency – by misallocation of talent and maintenance of power schemes, for instance – and by discouraging accumulation of human and physical capital. Moreover, the literature focusing this issue seems to hold a certain consensus on the notion that corruption affects productivity in an economy, and therefore the productive factors returns. The following section attempts to analyze how variables measuring a society's institutional development can be treated within the neoclassical framework of economic growth, in order to ascertain the basic relations between corruption and factor productivity.

3 Institutions, factor productivity and per capita income

The impact of institutional variables on economic growth, particularly regarding product level and growth, has recently been the subject a much research. The mainstream of this line of thinking include the concepts developed by the New Institutional Economy. Burki and Perry (1998) study the topic and present a summary of recent articles on growth

and institutions[6]. The main conclusions of these studies can be summarized as follows: (i) institutions that guarantee the property rights are crucial to economic growth; (ii) the degree of perceived corruption has a negative effect on economic performance; (iii) the trust between economic agents and civic cooperation has important effects on economic growth and factor productivity; and (iv) institutional development fosters economic growth and the convergence of developing nations to the standards of living of developed nations. In the words of Burki and Perry (1998), "institutions matter".

The set of studies that discusses the role of institutions in explaining economic growth is particularly useful in order to help evaluate the impact of corruption on the wealth of nations and their economic growth. This set is comprised of two groups of articles: (i) Hall and Jones (1996, 1999) and Jones (2000); and (ii) and Garcia et al (1999, 2001) and Bandeira (2000). These studies differ from the vast majority of work conducted in this area in two crucial aspects: first, they attempt to develop a simple theoretical framework to evaluate the impact of institutional development indicators on per capita income, where the causal link between the two phenomena is factor productivity. Second, empirical analysis is performed based on theoretical propositions, i.e., it is not an *ad hoc* procedure[7]. Regarding the second group, an additional aspect can be included: these authors work with theoretical formulation that allows identification of which productive factors have their productivity impacted by institutional changes.

This section presents a theoretical analysis of the possible effect of corruption on product level, considering the impacts of the first variable on factor productivity. From the perspective of this approach, that would be the main mechanism through which institutional variables affect a society's income level. By influencing factor productivity, institutions would also have indirect impact on accumulation decisions. This article is limited to exploring the direct mechanism.

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[6] In addition to the above-mentioned work of Burki and Perry (1998) a study prepared by Barro (1996) investigates the effects of a range of economic and institutional variables on economic growth.

[7] Generally speaking, empirical work introduces institutional change variables in regressions, in order to identify the effects on growth and its determinants. At times, these empirical models aggregate one or more institutional variables to the equation of the Solow model, or to that of Mankiw, Romer and Weil (1992), and evaluate the effects on estimated coefficients. In other cases, empirical analysis is performed through "informal regressions", as Temple (1999) calls them.

In order to develop this analysis, the framework suggested by Garcia et al (2001) was employed. The basic analysis reference is the aggregated production function, which defines the relation between aggregated product – by definition identical to rent – and the stocks of productive factors. This production function, known in the literature as the basis of the Solow model with human capital – equation (1) – has the following arguments: the stock of physical capital (*K*); knowledge (*A*), which reflects the degree of technological development of a given economy; and the endowment of human capital (*H*). This last variable is defined as the stock of workers (*L*) adjusted to their skill, which is estimated through average level of education of the labor force (*u*).

$$Y = (K)^{\alpha}.(A.H)^{1-\alpha}, \text{ where } H = e^{\phi.u}.L \quad (1)$$

The starting point is the broad idea that the degree of institutional development can affect factor productivity in different ways. This produces three theoretical possibilities: (i) corruption affects only the productivity of capital; (ii) it affects only the productivity of effective-human capital; and (iii) it affects the productivity of all productive factors, i.e., it affects the total factor productivity (TFP).

Based on the first hypothesis, called "effective-capital", it is possible to re-specify the production function of the Solow model with human capital – equation (1) – substituting the physical capital for a variable that expresses this factor adjusted to its productivity, which is determined by the degree of institutional development (*I*) – equation (2). Alternatively to the effective-capital hypothesis, it is possible to relate the institutional variable with the productivity of the human capital factor, in relation to the influence of the knowledge on this variable. This hypothesis is called "effective-human capital". In this case, human capital is replaced by a variable that expresses this factor adjusted to its productivity, as shown in equation (3). The last hypothesis considers the effect of the institutional variable on the total factor productivity, which implies that all factors have their productivity influenced by the institutional structure, as equation (4) shows.

$$Y = (IK)^{\alpha}(AH)^{1-\alpha}, \ 0 < \alpha < 1 \quad (2)$$

$$Y = K^{\alpha}(IAH)^{1-\alpha}, \ 0 < \alpha < 1 \quad (3)$$

$$Y = I\left[K^{\alpha}(AH)^{1-\alpha}\right], \ 0 < \alpha < 1 \quad (4)$$

Considering how the institutional variable is introduced in the production function, it is easy to understand the role this variable plays in product and income creation. In the case of equation (2), for instance, the fact that the institutional variable is multiplying the physical capital means that institutions change the productivity of this productive factor. Two economies with the same amount of all productive factors may, in this particular situation, have different production volumes simply because they have dissimilar levels of institutional development. The more developed economy, under this aspect, will have greater production, since its capital is more productive.

In the manner suggested by Garcia et al (2001) it is possible to empirically verify which of the hypotheses below equations (2) and (4) can be refuted, or not. This will allow to verify if corruption affects productivity of capital, of human capital, or of both. In order to do so, we can specify an empirical equation that represents the production function, such as (5)[8], which is used to estimate the α, $(1 - \alpha)$, γ and ϕ coefficients.

$$Y = I^{\gamma}.K^{\alpha}.\left(A.L.e^{\phi.u}\right)^{1-\alpha}.e^{\mu} \qquad (5)$$

It should be noted that in the empirical equation the most probable specification is not determined; institutions are attributed a γ coefficient. It is the comparison of this estimated coefficient with the other coefficients which allows us to determine the role of institutions. If it is not possible to refute the premise that γ is equal to α, then it can be said that corruption affects capital productivity. It it is not possible to refute the hypothesis that $\gamma = (1 - \alpha)$, then it can be said that corruption affects effective-human capital. Finally, if it is not possible to refute the premise that γ is equal to 1, it can be said that the third hypothesis is valid: corruption affects equally both productive factors, i.e., it affects total factor productivity.

Before going on to the empirical analysis of equation (5) and the tests of the subjacent hypotheses, it is worth mentioning the possibility to evaluate the same properties by way of a theoretical model that considers the equilibrium of the steady state of the economy[9]. Considering the traditional hypotheses of the economic growth models – Mankiw, Romer and Weil (1992), for instance – it is possible to derive from equation (2), where in-

[8] The term μ designates this equation's residual.

[9] Regarding this aspect, see Bandeira (2000) and Garcia et al (2001).

stitutions are capital effective, a specification which defines the product according to effective-human capital. The equation is thus rewritten in reduced form, as follows:

$$\tilde{y} = \left(I.\tilde{k}\right)^{\alpha} \qquad (2')$$

where $\tilde{y} = Y/A.H$, $\tilde{k} = K/A.H$ and $H = e^{\phi.u}.L$. The capital accumulation equation for this economy[10] can be written, in reduced form, as illustrated below, where s_k is the savings rate, n, the population growth rate, g, that of technological innovation and d, the depreciation rate.

$$\dot{\tilde{k}} = s_k.\tilde{y} - (n + g + d).\tilde{k}$$

In steady state, variations in the stock of capital per unit of effective-human capital is zero. Thus we have $s_k.\tilde{y} = (n + g + d).\tilde{k}$. By substituting expression (2') in this equation, we arrive at the value of k of steady state, given by:

$$\tilde{k}^* = \left(\frac{I^{\alpha}.s_k}{n + g + d}\right)^{\alpha/1-\alpha}$$

This gives us the equation of the product per unit of effective-human capital in steady state:

$$\tilde{y}^* = I^{\alpha/1-\alpha}.\left(\frac{s_k}{n + g + d}\right)^{\alpha/1-\alpha}$$

By defining y^* as the product per worker in steady state, we have the following expression:

$$y^* = I^{\alpha/1-\alpha}.\left(\frac{s_k}{n + g + d}\right)^{\alpha/1-\alpha}.A.e^{\phi u}$$

By linearizing the above equation using the natural logarithm, we have a new expression for the product per worker:

$$\ln(Y/L) = \frac{\alpha}{1-\alpha}.\ln I + \frac{\alpha}{1-\alpha}.\ln s_k - \frac{\alpha}{1-\alpha}.\ln(n + g + d) + \ln A + \phi.u$$

Assuming, similarly to Mankiw, Romer and Weil (1992), that the accumulation of knowledge is given by $A_t = A_0.e^{gt}$ and that $\ln A_{(0)} = a + \varepsilon$ – where a is a technological con-

[10] Identical to the accumulation equation of the Solow model.

stant, and that ε is a specific random shock in the economy, and by simplification, *t = 0* – we have the final specification, which includes a variable associated to the institutions, given by expression (6). An important aspect of this expression is the fact that the coefficient associated to the degree of institutional development, at least in theoretical term, is identical to that of the savings effort. Similarly to the tests announced above, if these coefficients are different, there is evidence that the degree of institutional development will not affect only capital productivity. In this particular case, it is expected that one of the previous premises will hold sway, whose empirical formulations follow the same construction logic of equation (6), and are expressed by equations (7) and (8).

$$\ln(Y/L) = a + \frac{\alpha}{1-\alpha}.\ln I + \frac{\alpha}{1-\alpha}.\ln s_k - \frac{\alpha}{1-\alpha}.\ln(n+g+d) + \phi.u + \varepsilon \quad (6)$$

$$\ln(Y/L) = a + 1.\ln I + \frac{\alpha}{1-\alpha}.\ln s_k - \frac{\alpha}{1-\alpha}.\ln(n+g+d) + \phi.u + \varepsilon \quad (7)$$

$$\ln(Y/L) = a + \frac{1}{1-\alpha}.\ln I + \frac{\alpha}{1-\alpha}.\ln s_k - \frac{\alpha}{1-\alpha}.\ln(n+g+d) + \phi.u + \varepsilon \quad (8)$$

Econometric estimation of these equations was based on expression (9), which considers the three possibilities above, as in the case of equation (5). Empirical evaluation of the coefficient associated to institutional development variable defines, according to the theoretical values anticipated by specifications (6), (7) and (8), the hypothesis whose associated probability is the highest: in this particular case, whether corruption affects only productivity of the physical capital factor, whether it affects exclusively the productivity of human capital or whether it has an overall impact on the productivity of the economy.

$$\ln(Y/L) = \beta_0 + \beta_1.\ln I + \beta_2.\ln s_k - \beta_3.\ln(n+g+d) + \beta_4.u + \varepsilon \quad (9)$$

4 Evidence regarding the effects of corruption on factor productivity

Econometric estimation performed in this section was based on data of a sample of 81 economies for 1998. The set of countries was defined by the availability of data regarding the variables specified in the previous section. Only nations that had quality information for both sets of regression – production functions and steady state equations – were included. Indicators of the degree of perceived corruption are presented in Kaufmann, Kraay and Zoido-Lobatón (1999). Education statistics came from Barro and Lee (2000).

The remaining variables of the theoretical models were built on information from *World Development Indicators 2000* – World Bank (2000).

As a hypothesis, a constant and equal depreciation rate was considered for all countries (3% per year). In addition, a technological innovation rate of 2% per year was also assumed, constant and identical for all economies. Regarding the index measuring the degree of perceived corruption, a change in the original variable was applied, in order to restrict these indicators to the interval between 0 and 1 – zero meaning the country with the highest level of corruption. This procedure allowed an estimate of factor productivity net of corruption, which is the case where the institutional variable takes on the highest value of the scale (1). Therefore, countries with higher corruption would have less productivity, which holds percentage relations with the factor productivity of the country with the smallest corruption, as shown in the scale [11].

To evaluate the effects of corruption on factor productivity, two alternative estimation methods were employed, which are associated to the very characteristics of the equations in question. Estimation of equation (5) applied the Levenberg-Marquardt non-linear regression model and that of equation (9) the Ordinary Least Squares model. Both estimates considered the reduced forms of the equation, wherein the dependent variable is the product per working age inhabitant (population between 15 and 65 years of age).[12]

In the case of the econometric model represented by expression (5), it was necessary to build a series of capital stock for the sample countries. To achieve this, the method suggested by Nehru and Dhareshwar (1993) was used. It employs series of gross investment and aggregated product growth to estimate the capital stock in a given moment in time, which corresponds to the average point of the period considered. This article used data from 1990 to 1998, which imply estimates of capital stock for 1994. This stock was updated until 1998 using the perpetual inventory method.

Regarding the estimation using the non-linear regression method, a set of three regressions was estimated. First, expression (1) was estimated, not considering human capi-

[11] Hall and Jones (1999) have adopted this procedure to compare degrees of technological development in a sample of countries.

[12] The estimation of equation (9) took into consideration the 38-year average (1960-1998) of the domestic savings rate of the countries in the sample and the average annual rate of population growth between 1960 and 1998.

tal, i.e., the production function of the Solow model. Next, the human capital variable was incorporated and equation (1), strictly speaking, was estimated. These two estimates are useful as references to the model in question, expressed by equation (5). Table 1 shows the main results of the estimations.

Table 1 Estimation of the production function in intensive form
Non-linear regressions using the Levenberg-Marquardt* method

Models	Basic	With human capital	With human capital and corruption
A / L	8,323.57	4,490.65	11,261.90
	(1,045.30)	(837.07)	(2,450.10)
K / L	0.47724	0.40442	0.33148
	(0.02447)	(0.02871)	(0.03101)
u		0.06143	0.03282
		(0.01485)	(0.01394)
I			0.43410
			(0.09509)
R^2	0.88706	0.90636	0.92748

Note: (*) the numbers in parentheses are standard errors of the estimates.

The models shown in table 1 are quite important for our discussion. First, it can be seen that the introduction of a variable that adjusts labor productivity to the average education of the labor force significantly improves the R^2 of the production function estimated. The already high R^2 rises further and, most important of all, the estimated value of the α parameter drops. According to some authors, an α estimate near 1/3 can be expected – Mankiw, Romer and Weil (1992), for instance – which reveals that this coefficient is overestimated in the basic model. The same happens when the degree of perceived corruption is introduced in the model: R^2 rises to almost 93% and the α coefficient is reduced to a value close to that expected (0.33148).

The estimated value of α comes close to the value of γ, suggesting that corruption is a phenomenon that affects only the productivity of capital. From the statistical perspective, tests can be performed to verify which hypotheses can be refuted: (i) $\gamma = \alpha$; (ii) $\gamma = (1 - \alpha)$; and (iii) $\gamma = 1$. In fact, the hypothesis tests presented in table 2 give evidence that the only hypothesis not rejected is the one which states that corruption affects only the capital productivity, i.e., the effective-capital premise.

Table 2 Hypothesis tests for the parameters γ and α

	H_0		
	$\gamma = \alpha$	$\gamma = (1 - \alpha)$	$\gamma = 1$
γ	0.434100	0.434100	0.434100
Var γ	0.009041	0.009041	0.009041
α	0.331490	0.668510	-
Var α	0.000962	0.000962	-
Cov(α,γ)	-0.001586	-0.001586	-
t-student*	0.893950	-2.042213	-5.951507
H_0	Not rejected	Rejected	Rejected

Note: (*) for comparison purposes, the t-table is 2.000, to a significance level of 5%.

Table 3 shows the result of the estimation of the steady state equation using the OLS regression model. A set of three regressions was also estimated: expression (9), disregarding human capital and institutions, i.e., the basic equation of Solow model's; the previous regression with the human capital variable; and equation (9), strictly speaking. Similarly to the previous case, these estimates serve only as references for the model under study.

In spite of a relatively high adjusted R^2, the first model appearing in table 3, similarly to the non-linear regression, overestimates the α coefficient, which in that particular case reached a value near 0.45. The introduction of average years of schooling, adjusting labor productivity, expanded the value of the adjusted R^2 and improved statistics associated to residuals as well as the α estimate. The introduction of the index that measures the degree of perceived corruption also had positive effects: the adjusted R^2 rises, reaching a value of α closer to the expected (near 1/3).

The estimate value of the coefficient associated to corruption (0.484) is also close to the value of the coefficient associated to savings rate (0.460), a result consistent with the premise that corruption affects capital productivity. The hypotheses that must be verified, in this case, are the following: (i) $\beta_1 = \beta_2$; (ii) $\beta_1 = 1$; and (iii) $\beta_1 = 1 + \beta_2$. These hypotheses tests are presented in table 4. Again, the tests show that the only non-rejected hypothesis is the effective-capital premise. This result confirms the previous one and clearly identifies corruption as a phenomenon that affects capital productivity.

Table 3 Estimation of product per worker of steady state
Regressions by Ordinary Least Squares*

Models	Basic	With human capital	With human capital and corruption
Constant	14.043	10.650	9.731
	(1.034)	(1.010)	(0.978)
lns_k	0.814	0.439	0.460
	(0.110)	(0.109)	(0.102)
ln(n+g+d)	-3.761	-2.057	-1.239
	(0.449)	(0.459)	(0.488)
u		0.186	0.139
		(0.030)	(0.031)
I			0.484
			(0.138)
implicit α	0.449	0.305	0.315
adjusted R^2	0.723	0.813	0.837
DW	1.790	1.914	2.029

Note: (*) the numbers in parentheses are the standard errors of the estimates.

Table 4 Hypotheses tests on the parameters β_1 and β_2

	H_0		
	$\beta_1 = \beta_2$	$\beta_1 = 1$	$\beta_1 = 1 + \beta_2$
β_1	0.484014	0.484014	0.484014
Var β_1	0.018976	0.018976	0.018976
β_2	0.460156	-	0.460156
Var β_2	0.010387	-	0.010387
Cov(β_2, β_1)	0.000815	-	0.000815
t-student*	0.143268	-5.951507	-7.691088
H_0	No rejected	Rejected	Rejected

Note: (*) for comparison purposes, the t-table is 2.000, to a significance level of 5%.

5 Final remarks

The theoretical discussion and econometric estimates described in the previous sections allow us to make some comments on the impact of corruption on a nation's wealth. The first issue is that corruption seems to be a phenomenon that reduces capital productivity. This would be, according to the analysis developed, the chief mechanism by which corruption reduces the product per worker (or per capita) in an economy. It is interesting to point out that tests performed by Garcia et al (2001), for another set of institutional development indicators – such as an regulatory framework or political stability – identify groups of institutions that fit the effective-human capital and total factor productivity hypotheses. This enables us to state that not all institutions are capital effective, i.e., it is possible to determine institution particularities regarding their role in economic performance.

Two other aspects related to loss of economic efficiency are important: (i) the reduction in potential income; and (ii) the effects on the long-term interest rate (the cost of capital). First, a loss in income is evident, arising from diminishing capital productivity, caused by corruption. For the average of the 81 countries comprising the sample, the statistical model provides income per worker close to US$14,601.74 in 1998. If all countries in the sample had the same index of perceived corruption seen in Denmark – the top ranking country in our scale – average income per worker in the sample would jump to US$18,328.15, or about 26% more income. This implies in an average waste of income of US$3,780.41 per worker, for the sample countries.

In the Brazilian case, in particular, waste is even more blatant, since the country is below the average rate of corruption in the sample of countries. For Brazil, the same statistical model provides income per worker close to US$12,145.34 in 1998. If, however, the country had a index of perceived corruption close to that of Denmark, income per worker would be US$17,353.55, implying in 43% economic growth. This means a waste of income of US$5,208.21 per Brazilian worker, or alternatively, a US$2,840.81 drop in per capita income.

In addition to this direct effect on the availability of goods and services in the economies, corruption also has direct impact on the long-term interest rate, since graft affects capital productivity. Considering that economies equal the returns of productive factors to their respective productivity, the statistical model infers an interest rate net of corruption costs close to 25.4% per annum, for the average of these 81 nations. When the effects of corruption are taken into consideration, this rate leaps to 78.7% for the average of these economies. In the case of developed nations – the case of Sweden, Switzerland and New Zealand, for instance – the difference between the interest rates is reduced to less than 2%. On the other hand, in poor or developing nations, this gap is considerably wider, since indexes of perceived corruption are also higher. Brazil is a good example of this. The econometric model shows a long-term interest rate close to 28.8% per annum, for 1998, whereas if the index of perceived corruption were higher, say that of Denmark, the interest rate would be 12.7%.

Statistical appendix

Table Data on economic and institutional variables

Country	GDP per worker, 1998 (US$, PPP)	Capital per worker, 1998 (US$, PPP)	Saving rate (1960-98)	Population Groutw (1960-98)	Mean years of scholling, labor force (1995)	Perceived Corruption Index
Algeria	8.136,06	18.256,50	30,79	2,72	4,83	0,1864
Argentina	19.284,95	32.934,69	22,44	1,49	8,46	0,3497
Australia	33.433,75	91.107,63	23,88	1,60	10,67	0,8572
Austria	34.077,64	176.806,93	26,30	0,36	8,05	0,8182
Bangladesh	2.400,58	1.351,22	10,61	2,38	2,41	0,3457
Belgium	35.059,20	143.255,27	21,15	0,30	9,10	0,6057
Benin	1.715,42	1.789,87	3,57	2,84	2,14	0,2127
Bolivia	4.044,78	3.684,32	16,30	2,30	5,31	0,3055
Botswana	11.136,49	19.142,73	26,22	3,15	5,86	0,5688
Brazil	10.190,01	26.712,76	21,10	2,19	4,45	0,4395
Cameroon	2.812,48	6.985,57	19,16	2,65	3,37	0,1251
Canada	34.591,65	103.042,51	23,05	1,39	11,39	0,9801
Chile	13.662,58	12.757,69	19,59	1,77	7,25	0,7024
China	4.594,33	2.364,82	31,57	1,64	6,11	0,3458
Colombia	9.677,14	8.620,47	19,51	2,35	4,96	0,2913
Costa Rica	9.691,51	13.006,13	18,89	2,94	5,77	0,5800
Denmark	36.011,05	141.718,63	24,28	0,38	9,39	1,0000
Dominican Rep.	7.454,57	8.049,33	14,35	2,50	4,66	0,2148
Ecuador	4.945,60	7.520,51	19,21	2,69	6,15	0,2023
Egypt, Arab Rep.	5.095,19	4.047,86	13,05	2,30	4,99	0,3516
El Salvador	6.836,18	5.446,67	9,83	2,27	4,70	0,3283
Fiji	6.695,09	9.150,41	16,86	1,85	8,08	0,6422
Finland	31.166,99	136.677,39	25,79	0,40	9,65	0,9880
France	32.304,62	146.596,12	23,50	0,67	7,42	0,7709
Gambia, The	2.654,38	1.648,28	4,39	3,32	1,95	0,4189
Ghana	3.254,91	1.905,80	8,78	2,67	3,75	0,3424
Greece	20.749,27	64.420,33	17,62	0,62	8,32	0,6471
Guatemala	6.617,50	5.232,03	10,85	2,67	3,25	0,2022
Guyana	5.235,70	5.435,46	19,82	1,06	6,00	0,4189
Haiti	2.516,86	2.244,40	3,21	1,85	2,83	0,2793
Honduras	4.482,23	4.950,08	16,73	3,15	4,50	0,1701
Hong Kong, China	29.038,56	125.224,15	29,76	2,08	9,29	0,7793
Hungary	15.001,51	54.607,05	27,58	0,03	8,83	0,5901
Iceland	38.828,42	136.144,85	23,41	1,17	8,48	0,9192
India	3.416,44	1.565,57	18,47	2,16	4,52	0,3412
Indonesia	4.152,17	4.360,83	23,41	2,06	4,55	0,2078
Iran, Islamic Rep.	8.735,99	7.339,53	27,03	2,82	4,73	0,1945
Ireland	32.480,34	39.092,02	19,61	0,71	9,08	0,8480
Italy	30.113,85	115.127,10	24,21	0,36	6,85	0,6410
Jamaica	5.496,84	18.629,02	21,29	1,21	5,02	0,3925
Japan	33.833,68	344.096,84	33,46	0,78	9,23	0,6197

Table Data on economic and institutional variables

Country	GDP per worker, 1998 (US$, PPP)	Capital per worker, 1998 (US$, PPP)	Saving rate (1960-98)	Population Groutw (1960-98)	Mean years of scholling, labor force (1995)	Perceived Corruption Index
Kenya	1.860,09	1.771,54	16,99	3,36	4,01	0,2477
Korea, Rep.	18.853,13	48.697,64	23,73	1,64	10,56	0,4670
Malawi	1.021,24	927,48	7,49	2,92	2,70	0,3713
Malaysia	13.296,68	21.903,91	31,31	2,67	6,49	0,5953
Mali	1.370,14	1.698,14	3,39	2,37	0,76	0,2952
Mauritius	12.221,40	17.032,02	19,29	1,49	5,79	0,5150
Mexico	12.534,79	20.590,76	21,26	2,54	6,96	0,3490
Netherlands	32.528,36	118.642,72	25,49	0,83	9,12	0,9722
New Zealand	26.332,12	93.504,09	23,17	1,24	11,49	0,9854
Nicaragua	3.963,58	3.456,63	8,57	3,03	4,09	0,1977
Norway	40.608,33	182.193,84	31,01	0,56	11,71	0,8803
Pakistan	3.150,84	1.715,01	9,75	2,81	3,92	0,2159
Panama	8.410,10	13.072,77	23,71	2,39	8,36	0,2999
Papua N.Guinea	4.070,23	7.381,59	13,92	2,33	2,58	0,1930
Paraguay	7.598,68	10.771,86	17,33	2,78	6,10	0,1646
Peru	7.054,53	14.713,13	23,64	2,44	7,31	0,3700
Philippines	6.016,31	6.073,02	20,25	2,68	7,88	0,3622
Poland	11.268,35	17.109,02	25,13	0,71	9,64	0,5570
Portugal	22.121,42	63.206,45	19,27	0,29	5,47	0,7535
Senegal	2.496,14	3.121,18	5,73	2,78	2,39	0,3602
Singapore	34.103,35	108.435,08	28,14	2,04	6,72	0,9509
South Africa	13.725,83	20.050,61	21,44	2,31	6,03	0,5048
Spain	23.676,84	80.017,21	22,63	0,68	6,83	0,7525
Sri Lanka	4.498,57	3.198,11	13,95	1,70	6,45	0,3904
Swaziland	6.969,51	10.432,24	23,60	2,96	5,63	0,4259
Sweden	32.300,27	146.757,52	21,85	0,44	11,23	0,9882
Switzerland	37.559,91	321.232,83	27,85	0,74	10,31	0,9845
Syrian Arab Rep.	5.301,30	6.390,03	11,61	3,23	5,48	0,2105
Tanzania	926,66	1.069,61	1,50	3,06	2,68	0,1740
Thailand	7.977,43	15.076,05	25,57	2,24	6,08	0,3794
Togo	2.680,16	1.774,29	17,16	2,88	3,15	0,3584
Trinidad&Tobago	11.298,65	21.239,23	27,74	1,12	7,44	0,5621
Tunisia	8.694,71	10.753,70	25,14	2,11	4,53	0,4294
Turkey	9.879,67	13.579,56	15,92	2,22	5,12	0,3295
Uganda	2.191,10	787,94	7,76	3,10	3,37	0,2979
United Kingdom	31.218,16	95.673,00	17,71	0,32	9,09	0,8857
United States	44.951,37	109.192,62	18,26	1,07	11,89	0,8046
Uruguay	13.777,60	15.919,08	16,92	0,68	7,31	0,5402
Venezuela, RB	9.544,99	18.555,83	30,61	2,99	6,69	0,2278
Zimbabwe	4.810,24	4.413,09	17,36	2,99	5,19	0,3377
Total	14.103,04	45.351,25	19,41	1,92	6,34	0,4899

Source: World Bank (2000), Barro & Lee (2000), and Kaufmann, Kraay & Zoido-Lobatón (1999).

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